Multidimensional Inequalities In China

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Abstract

The usual manner of describing inequality in a population, involves income distributions. China has experienced rapid income growth, led by reforms which have exacerbated income inequalities. Other components of well-being have been affected as well. Education and health care have become less accessible due to increased costs linked to the decentralization of the financing of such services. The changing face of inequality in China is therefore not confined to income. As such this paper applies new tools to the measure of multidimensional inequalities on wages, education and health.
The multidimensional aspect is critical because there may be compensating effects of one form of inequality with respect to others which can change the evolution of overall inequality. Results are submitted to the values of parameters which are included in the formulation of new indices and which translate the Chinese population's aversion to inequalities and the weight it gives to the different dimensions considered. My results show that there has been a significant increase in inequality in China between 1997 and 2000, irrespective of the dimensions one focus on, and that this increase is robust to reasonable variations in the underlying parameters.

Résumé

Habituellement, afin de décrire les inégalités au sein d'une population, la recherche utilise les inégalités de revenu. La Chine, en tant que pays en transition, connait une forte croissance générée par des réformes qui ont également eu pour conséquences d'augmenter les inégalités de revenu. Mais d'autres composants du bien-être ont été touchés. L'accessibilité à un bon niveau d'éducation et aux soins de santé a diminué du fait de la hausse des coûts de ces services liée à la décentralisation de leur financement. Ainsi, décrire les inégalités uniquement à travers la distribution des revenus ne semble pas suffisant. C'est pourquoi nous utilisons dans ce papier de nouveaux outils pour mesurer les inégalités multidimensionelles de salaires, d'éducation et de santé.
Nous trouvons qu'il est important de considérer plusieurs dimensions du fait d'un effet de compensation qui peut modifier l'évolution des inégalités multidimensionelles par rapport à celles unidimensionelles de salaires. Les résultats sont soumis à la valeur des paramètres inclus dans l'expression des nouveaux indicateurs et qui traduisent l'aversion aux inégalités de la population chinoise ainsi que le poids qu'elle donne aux diverses dimensions considérées. En ce qui concerne l'évolution des inégalités en Chine, nous constatons essentiellement une augmentation entre 1997 et 2000, quelles que soient les dimensions considérées et la valeur des paramètres.

Keywords: multidimensional inequalities, wages, education, health, China

JEL: O12, O15, I12, I20

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1. INTRODUCTION

Since the end of the seventies, China has experienced a period of exceptional growth. The transition to a market economy, which explains a substantial portion of this movement, has also been the root of the development of inequalities through the reforms it required. Actually, measures decided to place the country on the rails of economic development had different consequences on population, depending on whether people lived in cities or in the countryside, in the west, the center or the east, in one province or another.

Income inequalities in China are still a subject of research for economists since their causes and mechanisms are many (Bhalla *et al.* (2003), Gustafsson and Shi (2002), Shi (1999), Tsui (1998)) and since they can cause social conflicts[1] and more broadly constitute a fetter on growth (Benjamin *et al.* (2004)). The composition of income and its evolution are some of the explanations the literature gives to growing inequalities (Tsui (1996), Khan and Riskin (1998)). A component which occupies a growing place is wages. As non agricultural labor increases in importance, salaries play a role in the determination of income in both urban and rural households. For the latter, the development of non farm labor even in the countries give them access to new forms of revenue. Before the reforms, and following the emergence of the manufacturing sector in the Chinese economy, central planning implied wage equality with change being largely a function of seniority. This was a factor leading to greater equity but also to inefficiency. With the reforms and the opening up of the economy to foreign firms, competition has lead to the search for greater efficiency from workers. Wages have tended to be higher and bonuses have been created to reward good performance. Consequently, the structure of wages has changed towards more inequality.

Reforms have also had an impact on education and health through the decentralization of decisions in provinces whose budgets were not uniformly distributed. Allocating land to families and dissolving Mao's system of communes in which education and health infrastructure were easily accessible, led to a new trade-off between more educated or healthier children on the one hand, and a greater labor force through girls helping with domestic chores and boys working, on the other[2]. Consequently, both the demand for and the supply of education and health services have fallen in the poorer regions of China, creating inequalities not only in income but also in human capital.

Describing inequalities only in term of income can lead to inaccurate interpretation when one wishes to understand and quantify inequalities of well-being. Well being is not only composed of income but also of the access to knowledge and to good health. As Sen (2000) puts it, the pertinent question that one must pose is: "inequality in what?". And when we want to describe inequalities in well-being, we cannot limit our analysis to income inequalities. This is particularly true for China.

Recently, as this problem appeared in many other circumstances, authors worked on a way to describe what we can call "multidimensional inequalities"[3]. This new concept has as a goal to quantify inequalities taking into account the various fields where differences between individuals can exist. Some difficulties appear when we consider many dimensions. At first, we have to consider the relationship which can link one attribute[4] to another. And that is particularly true for income with, for example, education. The level of a monetary attribute has often an impact on the level of a non monetary one. Secondly, it is difficult to order distributions of multidimensional inequalities. The question is: what is more inegalitarian between someone who has a high income but a little level of education and someone who has a low income but a high level of education ?

The study of the construction of unidimensional inequality indices is based on a certain number of rules which are used to order distributions. For the multidimensional case, some rules have been extended, but others have to be created in order to face the new challenge of multi-dimensionality. Once the criteria have been established, indices of multi-attribute

[1] We can for example quote the troubles initiated by the working force in 1974 and 1975 whose claims were better work conditions and higher wages.

[2] Girls are kept at home to help for housework while boys help for agricultural work.

[3] We will use equally multidimensional or multiattribute inequalities.

[4] Attribute is another way to call the dimension we consider.

inequalities have been considered, so as to describe, in scalar form, multidimensional inequalities.

Here, we decide to focus on three dimensions: wages, education and health. These dimensions are closely linked but each covers a different aspect of well-being. Moreover, they give a picture of inequality in the accessibility to the labor market as determinants of the choice to work in the non agricultural sector. We use household level data from 7 provinces for the years 1991, 1993, 1997 and 2000. We will thus be able to see, at the individual level, the evolution of global inequalities during the reform process.

This paper is organized as follows. Section 2 shows why China is an interesting context in which to study multidimensional inequalities because, as mentioned earlier, reforms have had consequences not only on the structure of wages but also on the educational and health systems. Section 3 describes the degree of unidimensional inequality for each attribute, by looking at how they have evolved. Section 4 deals with multidimensional inequalities, presenting at first the tools we will use, and then applying them to the Chinese case. Section 5 concludes.

2. CHINA : A FIELD FOR MULTIDIMENSIONAL INEQUALITIES

To assess whether the study of multidimensional inequalities in China is relevant, we will show in a first step that important differences exist between individual in their wages, their educational level and their health status. We will see that these gaps are the results of changes in Chinese society, following the reform movement. Nevertheless, as we will see later, the reform movement began at the end of the 1970's implying that its consequences on the level of education and health of adults will appear several years later because of the inertia of policies over time. It will therefore be necessary to describe the population affected by this process in our sample for the appropriate years.

2.1 Wages Inequalities

Khan and Riskin (1998) show that wages, which represent an increasingly important fraction of revenues, are a factor that increases inequality. But wage differences between individuals are not necessarily negative if they translate various levels of work and efficiency in the work force. But, in studying the labour market, we note that a good deal of discrimination exists, which can in turn affect inefficiency and cause social conflicts.

The emergence of the labor market in China occurred after the Revolution which brought Mao Tse Dong and the communist Party to power. To develop his country, China's leader focused on the development of heavy manufacturing, following the model of his Russian counterpart Stalin. Wages in those industrial structures were equally distributed so that no inequalities could exist. In the rural sector, individuals were forced to belong to the new collective farms (Bergere (2000).

The reform process had many consequences on the work organisation. For manufacturing, the openess of the economy to foreign investments and the search for higher profits, led industries to look for more efficiency in the face of tighter budget constraints. Inequality in the distribution of wages appeared with the creation of bonuses to pay more the best workers (Coady and Wang (2000)).

In rural areas, many alternatives were offered to former employees of the collective farms that were dissolved: obtaining one's own land was possible, though corruption was often a hindrance to this process ; they could also choose to look for work in enterprises set up in their towns or provinces. Limitations on migration between provinces and sometimes even between towns (with a registration system called Hukou), constitutes the first obstacle to access to the labor market. Even if the off farm jobs play an increasingly important role, we can also note inequalities in access to the off-farm labor market. For poor villages, individuals cannot find jobs and are restricted to subsistence agriculture, while inhabitants of the richer villages have access to heavy manufacturing (Braun (2000), Benjamin *et al.* (2003)).

Therefore parallel to the reforms, growing unemployment appeared in some geographic zones mainly in the country side or interior regions of the country. Moreover, even if individuals succeeded in getting a job, wages discrimination existed and still exists in the system. Gender discrimination, on the one hand (Li and Zax (2004), Maurer-Fazio *et al.* (1999)) but also differences between native urban dwellers and migrants from the country (Maurer-Fazio and Dinh (2002), Meng and Zhang (2001)). An individual's sex and origin determine both the level of their wages and the type of work they perform. For example, 4 percent of migrants work as white collars workers against 35 percent for native urban dwellers. Women are more likely to be employed in low paying jobs.

Moreover, the structure of wages differs between public, private and foreign enterprises. The latter must pay their employees higher wages so as to compensate them for the advantages in kind employees can get by working for a public enterprise. Chen *et al.* (2005) show that the best paid workers are employed by foreign enterprises, while urban collective enterprises pay the lowest wages. Salaries in the former are 71 percent higher than in the latter, 50 percent higher than in private/individual enterprises, 37 percent higher than in local enterprises and 17 percent higher than in State Owned Enterprises (SOEs).

While wage inequality can favor the working of the labor market, discrimination exists in China and this can have important consequences in terms of social conflict.

2.2 Inequalities In Education

One of the major points in Mao's policy was to develop an educational system which was accessible to every one and which was egalitarian. Hannum (1999) describes it as a socialist egalitarian model. Some authors suggest that the Cultural Revolution, which had been a catastrophe for education, particularly for secondary and university education, had been a means for poor rural populations to gain access to primary education and even to litteracy (Han (2001)). In reality and even today, the educational system is far from being egalitarian. The reforms have contributed to this through different channels.

In may 1986, a wave of reforms[5] gave the total responsibility of primary education to local government (Connelly and Zheng (2003), Law (2002)). The decentralization of decision making and financing concerning education created distorsions in the provision of education between the different provinces. Even if the goal of 9 years of compulsory school was set by the government, only provinces that had negociated higher budgetary allocations could attain the objective of providing good educational services with competent teachers with an adequate level of training. For poor provinces, conditions in schools were often precarious. Teachers left such provinces to earn more in richer ones. As a result, access to schooling and to good teachers is highly heterogeneous across the population. This is confirmed by Liu (2001) who shows that a part of the inequality in wages stems from inequality in training. That the government is aware of this situation is underlined by a 1997 World Bank report (Hossain (1997)). Nevertheless, inequality in education continues to increase (Zhang and Kanbur (2005)).

Households, even if they realize the importance of education in the growing economy of China[6], face tighter budgets. Gustafsson and Li (2004) and Fang *et al.* (2002) show that there has been an increase of the share of educational expenditures in the family budgets. Moreover, this rise is a decreasing function of household income.

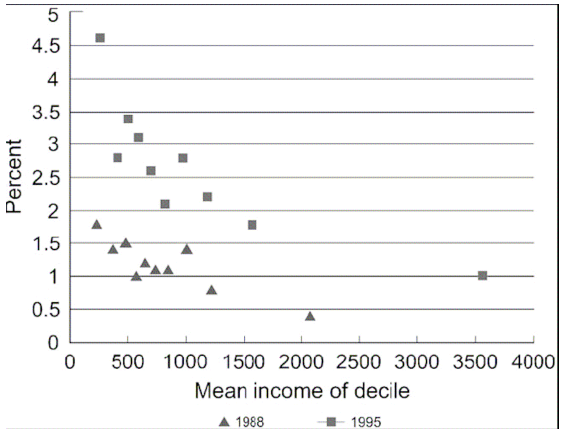

Figure1: Education expenditure in rural China (1988 and 1995) as a percentage of disposable income I.
Source: Gustafsson and Li (2004). Figure 1, p. 296.

Households face a new trade-off between sending their children to school, paying for their schooling, and keeping them at home, which can be an added resource when they work on the farm or at home. Moreover, decollectivisation gave a new role to the family, especially in rural areas. Since household members have to work more to reach a given level of income, priority is not always given to education. Even if the law constrains families to send their children to school during 9 years, Liu (2004) shows that the decision about schooling is, fundamentally, the family's own private decision. Thus, both the supply of and the demand for education has been modified by the reform movement that began at the end of the 1970's.

2.3 Inequalities In Health Status

As with education, we can distinguish two periods, before and after the reforms. At the time of the communist regime, 85 % of villages had a health station staffed by barefoot doctors who provided basic preventive and curative care. Townships had the responsibility for health centers, and counties for county health bureaus (Bloom and Xingyuan (1997)).While the level of health improved during this period, the reform process and the transition to a market economy has had consequences on the health system, especially in terms of its financing (Worldbank (1997)).

Bloom and Xingyuan (1997) find three major consequences of the reform process. First, greater inequalities in the access to health care, with heavy disparities between rural and urban populations. Second, a rise in health care costs, which stems from the rise of health workers' wages and the increase on drug prices. Third, the weakening of preventive services.

Decentralization placed the financing of primary health care in the hands of the provinces. The proportion of health expenditure directly borne by the central government declined from 38.2 % in 1985 to 26.6 % in 1990 (Ho (1995)).

The government encourages more and more hospitals to be financially independent. Users must pay

[5] Law (2002) gives six national education laws: Regulation on degrees (1980), Basic education law (1986), Teachers law (1993), Education law (1995), Vocational Education law (1996), Higher education law (1998). Reforms undertaken after 1990 will have an impact on educational level of cohorts younger than those considered in this study. But we will see the impact of the most important one, the decentralization of decision making and financial constraints.

[6] Liu (2004) quotes a household member relative to schooling: "Sending the child to primary school at a certain age has become a practice that has been internalized in the Chinese people's mind".

for medical services and give priority to the provision of expensive cares. As with education, health care expenditures represent an increasing proportion of household budgets (Gustafsson and Li (2004)).

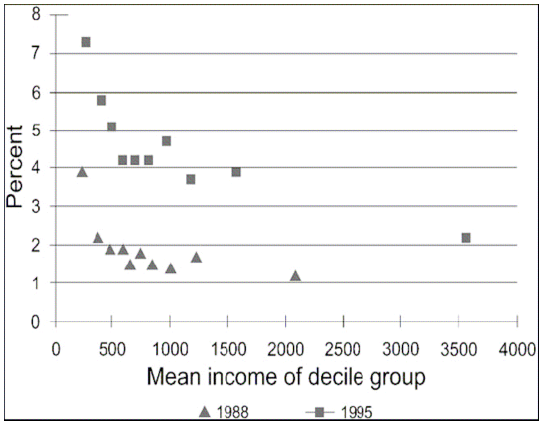

Figure 2: Health care expenditure in rural China (1988 and 1995) as a percentage of disposable income I.
Source: Gustafsson and Li (2004). Figure 2, p. 297.

In rural areas, before decollectivization, people benefited from cooperative medical care schemes. 80 to 90 % of the rural population were covered in 1979. In 1995, only 20 % continued to benefit from this system (Ho (1995)).

Concerning insurance, the traditional system[7] collapsed, leading to an increasingly important role for consumer fees. Alongside public insurance, individuals can have private insurance, but which is essentially restricted to urban areas. Nevertheless, Liu *et al.* (2002) and Henderson *et al.* (1998) show that there is no evidence of a decrease in the access to health care services and that the new insurance model is more equitable in ensuring access to primary care for out-patients.

3. UNIDIMENSIONAL INEQUALITIES OF WAGES, EDUCATION AND HEALTH: EMPIRICAL RESULTS

3.1 Inequality Measurement

To measure unidimensional inequalities, many tools can be used. Inequality tends to describe the distribution of revenue (usually) among the population. So measures as variance or standard deviation seem to be good instruments to describe this phenomenon. However, those two indicators are not desirable because they don't answer some conditions required to order inequalities, to compare different levels[8]

Various indicators have been built from established rules (Sen (2000), Litchfield (1999), Blackorby *et al.* (1999)).

To describe unidimensional inequalities in our sample for the three dimensions wages, education and health, we will use three types of indicators.

The GINI coefficient:

The most popular measure of income inequality, this indicator is associated with the Lorenz curve which represents the cumulative percentage of revenue as a function of the cumulative percentage of the population. Formally speaking, if we consider n individuals where the *i*-th one has an income y_i, *i* running from *1* to *n*, the GINI coefficient is given by :

$$GINI = \frac{1}{2n^2\bar{y}} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| y_i - y_j \right| \qquad (1)$$

where $\bar{y}$ is the mean of income for the whole sample.

Its decomposition is still fragile because the terms which are issued from an eventual decomposition do not all have significance (Shorroks (1999)). A second drawback of this indicator is that it does not tell one anything about the relative positions of the various income categories considered in its calculation. Many revenue distributions can correspond to a given value of the GINI coefficient.

Generalized entropy class of measures:

They are given, using the same notation as before, by the following formula :

$$GE(\alpha) = \frac{1}{\alpha^2 - \alpha} \left[\frac{1}{n} \sum_{i=1}^{n} \left(\frac{y_i}{\bar{y}} \right)^{\alpha} - 1 \right] \qquad (2)$$

The parameter α represents the weight given to distances between incomes at different parts of the income distribution, and can take any real value. For small (large) values of α, GE(α) is more sensitive to changes in low (high) levels of income. We will use the usual indice called Theil's measure given for a value of 1 for α what gives :

[7] The traditional scheme is composed of a publicly-funded medical care system which covers civil servants, workers in public agencies, universities; the labor insurance medical care which protects employees in state and collective enterprises and their immediate family members; and the cooperative medical care scheme for rural areas. All these structures ask more and more their clients to pay for their care.

[8] For example, variance is not independent of the income scale. If we double all incomes, we would obtain a quadrupling of the estimate of inequality.

$$GE(1) = \frac{1}{n}\sum_{i=1}^{n}\frac{y_i}{\overline{y}}\log\frac{y_i}{\overline{y}} \qquad (3)$$

This indicator can be decomposed in two parts. One describes the inequality between groups, and the other the inequality within groups. We will not use this decomposition in this study, this has been done for China for differences between urban and rural population, and for the different provinces (Bhalla *et al.* (2003), Gustafsson and Li (2002)).

Atkinson class of measures:

These measures consider the loss of well-being due to the existence of inequality. Stemming from a normative approach, they are based on the construction of a social welfare function. This one must respect a number of criteria such as reflexivity, transitivity and antisymmetry (Blackorby *et al.* (1999)). All inequality indicators are not based on social evaluation functions (for example, the class of generalized entropy measures). The GINI coefficient is a particular case of an indicator based on this type of function, as represented by the Lorenz curve. We will see that the reference to a function to build indicators has been taken to describe multidimensional inequalities.

Atkinson's indicators are given by :

$$A_\varepsilon = 1 - \left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i}{\overline{y}}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \qquad (4)$$

where ε is the parameter of inequality aversion. The values of the Atkinson measure of inequality are between 0 and 1, 0 being the egalitarian situation. We will arbitrarily take ε =0.5 for the study of unidimensional inequalities.

3.2 Data And Procedure

We are going to describe inequalities level in our sample and for each dimension to see how they evolve between the beginning of the nineties and the beginning of 2000.

Sample description:

We use micro data from the China Health and Nutrition Survey (CHNS) carried out in 1991, 1993, 1997 and 2000. The CHNS is an ongoing longitudinal survey that covers eight provinces (Guangxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Liaoning and Shangdong). Since 1997, Heilongjiang has replaced Liaoning province. We exclude these two provinces from our sample for 1991 to 2000. Although the survey is not nationally representative, these provinces were selected to provide significant variability in geography, economic development and health indicators, so that they may be considered to be generally representative of all provinces in the country.

A multistage random-cluster sampling procedure was used to draw the sample from each of the provinces. The counties in the eight provinces were stratified by income (low-, middle- and high-income tertiles) using the per capita income figures from the State Statistical Office, and a weighted sampling scheme was used to randomly select four counties in each province (one low income, two middle income, and one high income). Probability-proportional-to-size sampling was used to select the sample from these units. In addition, urban areas initially not within the county-strata were later incorporated by including the provincial capital and a low-income city from each province. Within each county, the township capital was selected and three villages were chosen randomly. Within each city, urban and sub-urban neighbourhoods were randomly selected. The same random selection was used for the selection of neighbourhoods from townships and villages.

Our basic sample consists of individuals of more than 16 years of age, whose anthropometric measurements fall within the bounds of what is considered reasonable by nutritionists in the Chinese context. For this sample, individuals have finished their schooling, which allows us to study educational inequalities.

If we look at the urban/rural decomposition of the sample, for each year, approximately 50% of individuals live in the country side and 50% in towns. Men represent 60% of the sample for each year. Wages are considered for individuals who have paid-work as their first occupation. They do not include bonuses, which can be a weakness of this study, since they represent a non negligible part of total salaries.

Educational levels are measured by the highest level of education attained (in years).

In terms of health status, anthropometric information was obtained concerning all survey participants[9], and we only make use of a small subset of the available measurements in this paper. Here, we use the Body Mass Index (BMI) as our measure of health status. BMI reflects short-term variations in nutritional and health status, since it depends on both past and present investments in health (Strauss and Thomas (1998)). At low levels (below 21), BMI is associated with wasting and elevated risks of mortality and chronic morbidities. At high levels (above 28), it is associated with obesity, an increasingly important risk factor in both developed or transition economies (Popkin *et al.* (1995), Popkin (1998), Doak *et al.* (2002), Schultz (2001)). Data from developing countries typically display significant subpopulations for whom BMI is below 18. The economic transition in China has been

[9] Measurements were carried out by trained health workers who followed standard protocols and techniques.

accompanied, as in other low income contexts, by a nutritional transition, leading to a decrease in the prevalence of undernutrition, but also to the appearance of problems of overnutrition due to various changes in dietary habits (Zhai *et al.* (2002), Du *et al.* (2004), Popkin *et al.* (1995)).

Descriptive statistics in table 1 give us a first picture of wages, education and health status for our sample for the various years.

Table 1: Summary statistics

	Observations	Mean	Standard deviation	Min	Max
Wages					
1991	2039	0.652	0.906	0	30
1993	1738	1.025	1.993	0	44.634
1997	1946	2.622	2.002	0.238	27.5
2000	1588	3.749	3.633	0.125	62.5
Years schooling					
1991	2039	8.353	3.307	0	18
1993	1738	8.509	3.241	0	18
1997	1946	9.154	3.109	0	17
2000	1588	9.422	3.167	0	18
BMI					
1991	2039	22.047	3.285	14.741	46.99
1993	1738	22.075	3.311	14.880	54.881
1997	1946	22.824	3.458	15.271	54.911
2000	1588	23.050	3.699	15.204	50.297

As should be obvious from the Table 1, we can see that the level of each attribute grew between 1991 and 2000. The status of individuals is improving on average as regards income, education and health. Considering standard deviations, which yield a first approximation of disparities in our sample, we see that it increased continuously for wages, even if the increase was not particularly marked between 1993 and 1997. The standard deviation of educational attainment decreased, except for the period between 1997 and 2000. Finally, the standard deviation increased for the BMI. A first approximation is therefore that wage inequalities increased, educational inequalities decreased, while health inequalities increased. We will see later whether these results are confirmed by the analysis of more sophisticated indicators of inequality.

Procedure followed:

China is an interesting country in which to study multidimensional inequalities because of its reform process. Nevertheless, reforms do not have an impact on the whole population we consider here, especially when education and health are concerned because of the inertia of the political process.

For education, reforms began with an impact for children aged between 6 to 15 year of age in 1980. Children who were at school earlier were not touched by reforms in the educational system.

For health, given that we use BMI at adulthood to describe health status, we will capture different elements of the evolution of health in the Chinese population. Since the BMI is a medium term indicator of nutrition, we will see the impact of the nutritional transition on adult diet through its impact on weight, and that whatever the age of individuals considered in the full sample (from 16 to 73 years of age). The BMI displays two other phenomena. The first is child care provided in early childhood (0 to 5 years of age). The second is the nutrition of children between 6 and 13 years of age which has been shown to have an impact on the nutritional status of adults, and particularly their BMI (Wang *et al.* (2000)). For the two last categories, all the sample population was not touched by reforms, initiated in 1980, which had consequences on both child care system and nutrition during childhood. Consider figure 3[10].

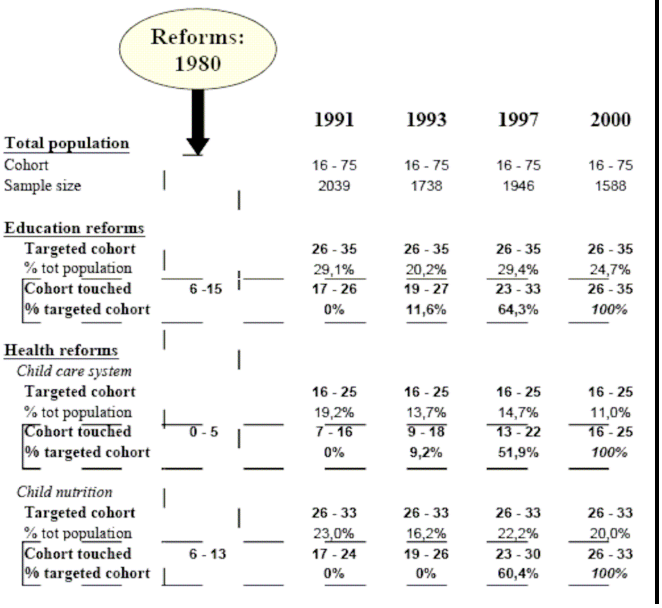

Figure 3: Cohorts affected by the reforms in different fields.

We see that if we want to have the whole population touched in 2000 by education reforms, we have to consider individuals between 26 and 35 years of age in 2000.

For the reforms concerning child care during early childhood, we have to consider individuals who were between 16 and 25 in 2000. For the impact of the nutrition transition of children, we must take individuals between 26 and 33 years of age in 2000.

We will therefore study unidimensional inequalities first, followed by multidimensional inequalities, on three separate samples. The first is the whole population of the sample (age between 16 and 75). The second will be individuals between 16 and 25 for each year. And the third will be individuals between 26 and 33 for each year. A percentage of the population

[10] What we call "targeted cohort" describes the cohort for which all individuals were touched by the reforms in 2000.

considered each year will be in the category of individuals touched by the reforms (see figure 3), considering that 100 % of the population was touched in 2000.

3.3 Results

Results are summed up in tables 2, 3 and 4.

Table 2: Unidimensional inequalities for the full sample.

	1991	(%)	1993	(%)	1997	(%)	2000
Wages							
Theil	0.2910	+59.24	0.4634	-58.95	0.1902	+36.17	0.2590
Atkinson	0.1126	+48.13	0.1668	-48.62	0.0857	+28.59	0.1102
Gini	0.3309	+23.39	0.4083	-23.02	0.3143	+12.31	0.3530
Education							
Theil	0.1034	-7.83	0.0953	23.61	0.0728	-2.88	0.0707
Atkinson	0.0745	-7.65	0.0688	27.62	0.0498	-3.81	0.0479
Gini	0.2114	-4.21	0.2025	11.16	0.1799	-0.28	0.1794
BMI							
Theil	0.0103	0.00	0.0103	+2.91	0.0106	+13.21	0.0120
Atkinson	0.0050	0.00	0.0050	+4.00	0.0052	+11.54	0.0058
Gini	0.0764	-0.92	0.0757	+2.64	0.0777	+6.69	0.0829

Table 3: Unidimensional inequalities for individuals between 16 and 25 years of age.

	1991	(%)	1993	(%)	1997	(%)	2000
Wages							
Theil	0.2742	-21.37	0.2156	+12.62	0.2428	+51.77	0.3685
Atkinson	0.1142	-12.00	0.1005	+0.50	0.1010	+48.51	0.1500
Gini	0.3460	-1.70	0.3401	-1.52	0.3349	+21.56	0.4071
Education							
Theil	0.0350	-16.57	0.0292	-7.19	0.0271	-22.14	0.0211
Atkinson	0.0197	-11.67	0.0174	-9.77	0.0157	-32.48	0.0106
Gini	0.1268	-11.99	0.1116	+0.36	0.1120	-0.45	0.1115
BMI							
Theil	0.0095	+13.68	0.0108	-15.74	0.0091	+43.96	0.0131
Atkinson	0.0045	+13.33	0.0051	-13.72	0.0044	+40.91	0.0062
Gini	0.0674	+2.97	0.0694	+1.73	0.0706	+13.31	0.0800

Table 4: Unidimensional inequalities for individuals between 26 and 33 years of age.

	1991	(%)	1993	(%)	1997	(%)	2000
Wages							
Theil	0.2323	-9.99	0.2091	-9.23	0.1898	+19.18	0.2262
Atkinson	0.1034	-7.06	0.0961	-14.46	0.0822	+20.19	0.0988
Gini	0.3116	-9.24	0.3404	-11.16	0.3024	+12.50	0.3402
Education							
Theil	0.0308	+9.74	0.0338	-1.48	0.0333	+16.52	0.0388
Atkinson	0.0192	+0.00	0.0192	-3.12	0.0186	+30.64	0.0243
Gini	0.1143	+12.60	0.1287	-0.85	0.1276	+6.27	0.1356
BMI							
Theil	0.0097	-20.62	0.0077	+28.57	0.0099	+6.06	0.0105
Atkinson	0.0047	-21.28	0.0037	+29.73	0.0048	+6.25	0.0051
Gini	0.0717	-9.90	0.0646	+16.72	0.0754	+3.05	0.0777

Figures 4, 5 and 6 describe the evolution of the different types of inequalities, for the three samples considered. We analyze each figure to see how the various groups were affected by inequalities.

Wage inequalities:

Consider first the full sample.

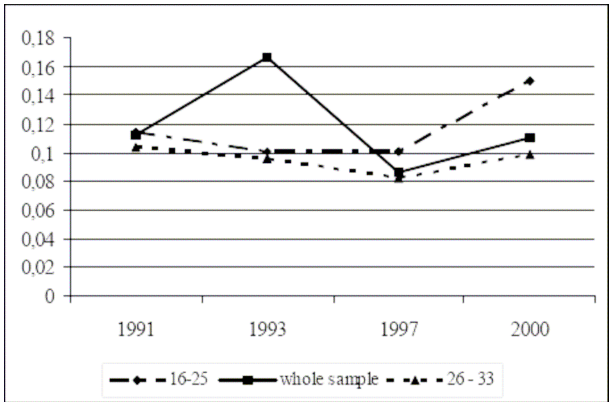

Figure 4: Wage inequalities for the different sub samples.

We see that the most important rise in inequalities occurred between 1991 and 1993. An initial decrease was followed by a slight increase. This is in agreement with the literature (Khan and Riskin (1998), Benjamin *et al.* (2003), Coady and Wang (2000)) which shows an increase in wage inequalities due to liberalization and the opening up of the labor market. But as our measure of wages does not take bonuses into account, which are one of the major causes of salary inequalities, inequalities could have been greater.

Given that we have measures of inequalities for different cohorts, we can see which individuals are particularly affected. Between 1991 and 1993, individuals between the ages of 16 and 33 saw wage inequalities decrease while inequalities increased for the older individuals (aged more than 33 years of age). This would appear to be reasonable given the need for better qualified workers, who are usually younger because of their higher level of training. Between 1993 and 1997, only individuals between 16 and 25 displayed an increase in inequalities. This is confirmed for the years 1997 and 2000, a period over which inequalities rose for all groups, because of the greater degree of competitiveness in the labor market.

Educational inequalities:

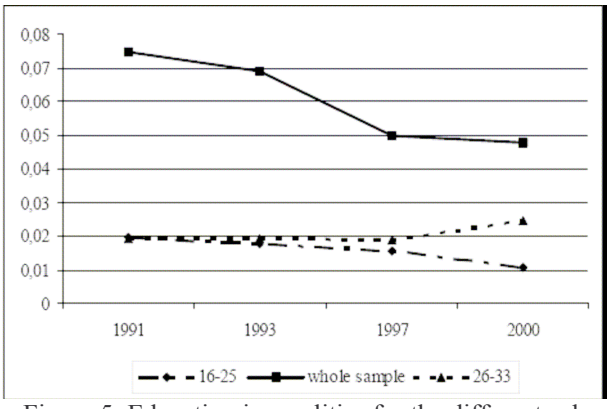

Figure 5: Education inequalities for the different sub samples.

For the full sample, one observes a continuous decline in inequalities. Nevertheless, this first result concerns individuals who have not all been affected by the reforms since the percentage of individuals concerned by the reform movement is low (2.3% in 1993, 21.2% in 1997 and 24.7% in 2000). When we look at the sub-group of individuals aged between 16 and 25, we see that there was also a decrease during the period. This is an interesting result because all the individuals considered here have been affected by the reform process. If we look at figure 3, we see that the persons affected by changes were between 17 and 24 year of age in 1991. Each year, individuals included in the sub-group 16-25 were either old enough, or younger than the limit for being included in the reform movement. Moreover, if we look at individuals aged between 26 and 33 years of age, the U-shape of inequalities evolution between 1993 and 2000 seems to show that when reforms were launched, inequalities in the access to education rose. But with time, inequalities decreased within younger cohorts.

These results are not in accordance with those of Zhang and Kanbur (2005). Nevertheless, their study used provincial data, and considered essentially spatial inequalities. At the individual level, it seems that inequalities decreased, whereas at a higher level of aggregation, disparities among provinces, and between urban and rural populations were rising.

Health inequalities:

Finally, we consider inequalities in health status.

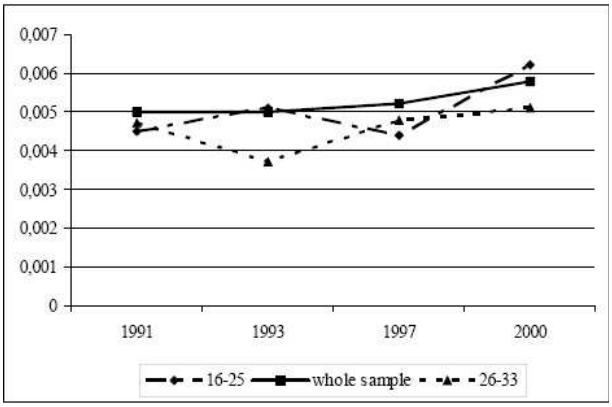

Figure 6: Health inequalities for the different sub samples.

For the full sample, one observes a continuous increase. If we consider that adult BMI translates the evolution of nutritional status and particularly of the transition in an individual's dietary habits, we can see that inequalities in the access to food appear to exist.

When we look at individuals affected by reforms in the area of child care services, a different phenomenon appears. We see at first an increase in inequalities for individuals of the 16 to 25 years of age cohort, between 1991 and 1993. Nevertheless, this does not translate the effect of the reforms. But for individuals who experienced the reforms, we see a dramatic increase (between 1997 and 2000). This could

be a translation of the decrease of government health expenditures in the fields of prevention and child care.

Concerning the impact of the reforms on the nutrition of children between 6 and 13 years of age, it seems that for adults who were not affected, inequalities in nutrition decrease, but as the share of individuals affected by the reforms rose, inequalities also rose. This was true from 1993 to 2000. This confirms the rise of inequality in the access to food as well as increasing inequality in terms of health status.

This is in accordance with the study of Zhang and Kanbur (2005) who looked at the inequalities in infant mortality at the spatial level. They also noted an increase in inequalities. Our results are also in accordance with Bloom and Xingyuan (1997) who found decrease in the access to health services, and with Popkin *et al.* (1995) and Du *et al.* (2004) who demonstrated an unequal access to food in China.

It is thus clear that the reforms have had differential consequences both on different subsets of individuals and on the various dimensions of welfare considered here. What is particularly interesting for our study is that these inequalities do not evolve in the same direction over time. This is an important point because we cannot predict which dimension will impose its variation when we shall aggregate them into a multidimensional indicator.

4. MULTIDIMENSIONAL INEQUALITIES IN CHINA

We have seen that China has experienced changes in inequality along various dimensions and that considering only the income aspect of inequality will not yield a full picture of inequality in China.

Given that inequality and poverty are multidimensional brings one to the issue of how to describe these phenomena quantitatively: the worse problem one faces is that of how to aggregate. This is both difficult and the subject of a good deal of controversy, because choices must be made concerning how the various dimensions are weighted.

4.1 Multidimensional Indices

In the unidimensional case, one faces a vector of income values for n individuals indexed by i. In the multidimensional case, one faces a set of matrices whose column j represents attribute j and whose line i represents individual i. If we have k attributes (for our case, k=3), and n individuals, the size of our matrix is $n \times k$.

Two major problems occur when we are interested in multidimensional inequality. The first one is ordering distributions containing various attributes. One has to find criteria which allow one to indicate the dominance of one distribution over another (Muller and Trannoy (2003), Savaglio (2001)). The second one comes from the fact that attributes can interact, especially income with non-income dimensions. We can see, looking at table 5, that in our sample, wages are positively correlated with other dimensions (except for education for the years 1991 and 1993).

It is therefore necessary to have rules which ensure that indices constructed take into account the correlation between attributes.

Table 5: Correlation between welfare dimensions
Note: H_0: Independence of the two variables.

	Education		BMI	
	Pearson correlation coefficient	Spearman rank correlation	Pearson correlation coefficient	Spearman rank correlation
1991				
Wages	-0.068	-0.0384	0.011	0.132
Education	1.000	1.000	-0.097	-0.089
BMI			1.000	1.000
1993				
Wages	-0.007	-0.017	-0.011	0.029
Education	1.000	1.000	-0.057	-0.035
BMI			1.000	1.000
1997				
Wages	0.048	0.115	0.000	0.085
Education	1.000	1.000	-0.026	-0.024
BMI			1.000	1.000
2000				
Wages	0.093	0.2125	0.074	0.099
Education	1.000	1.000	-0.019	-0.0285
BMI			1.000	1.000

Multidimensional GINI and Atkinson indices:

The normative approach of inequality used by List (1999) leads to the extension of the GINI and Atkinson measures of inequality. List uses utility functions to aggregate dimensions in a first step and then considers two types of aggregation functions: the first is the generalized Lorenz curve, the second is the generalization of the social evaluation function used for the construction of the Atkinson's index. So as to satisfy various axioms, the aggregation function must respect a number of properties. Let u be one of these functions. List (1999) showed that u must be continuous, increasing and strictly concave. Let us consider a vector whose arguments are t_i (i going from *1* to k) and the functions $f_j : R^+ \rightarrow R^+$. u must be of the form (Proposition 4.3. p.11 in List's paper):

$$u(t)=f_1(t_1)+f_2(t_2)+...+f_k(t_k) \qquad (5)$$

To describe relative inequalities among individuals, the index must be sensitive only to the relative distribution of attributes. We are therefore solely interested in the position of a given individual with respect to the mean of the sample. List (1999) defined the compensation matrix whose elements are the value of one attribute for each individual divided by the mean of the sample for the attribute considered.

Each element of the matrix obtained describes the proportion of attribute *j* held by individual *i*. This transformation of the initial matrix is necessary for one to obtain a complete aggregation which respects the desired axioms[11].

This way, List (1999) defined two indicators.

The GINI multidimensional indicator is obtained from the generalized Lorenz curve and is as follows (Definition 5.3. p 16):

$$I^n(X) = 1 - \frac{\sum_{i=1}^{n}\sum_{m=1}^{n}\min\left(\sum_{j=1}^{k}\left(\frac{x_{ij}}{\mu_j}\right)^{r_j}, \sum_{j=1}^{k}\left(\frac{x_{mj}}{\mu_j}\right)^{r_j}\right)}{k \times n^2} \quad (6)$$

Where $0<r_j<1$ for each *j*, and *k* is the number of attributes.

Atkinson's multidimensional inequality index is obtained from the social evaluation function and is given by (Definition 5.7. p 19):

$$I^n(X) = 1 - \left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{1}{k}\sum_{j=1}^{k}\left[\frac{x_{ij}}{\mu_j}\right]^r\right)^s\right]^{1/r\times s} \quad (7)$$

Where $0<r, s<1$, and *k* is the number of attributes.

We see that each indicator is a function of parameters. For Atkinson's index, if we establish the parallel between the unidimensional Atkinson's indicator and its multidimensional counterpart, we can interpret *r* as the parameter of aversion to inequality. For the GINI coefficient, *r* translates the relative weight placed on a given attribute. It can be the same for each attribute, but we see that the expression for the GINI coefficient permits one to give different weights to each various attribute. It will be important when we will look at multidimensional inequalities to see if the values of the parameters for the different indicators have an impact on the results.

4.2 Results

To the best of our knowledge, only one study describes multidimensional inequality using multiattribute indicators. Justino (2005) uses Maasoumi's indicator (Maasoumi (1986)) and multidimensional stochastic dominance (Atkinson and Bourguignon (1982)). The List indicators that we use satisfy more optimality properties than Maassoumi indicators, essentially because they take the correlation between inequalities in the various attributes into account (List (1999)).

Two other studies has considered the problem of the multidimensional aspect of inequality, using principal components analysis (Quadrado *et al.* (2001)), or through a pair-wise joint distribution analysis (Justino (2004)).

Justino *et al.* (2005) found it to be particularly important to consider inequalities as a multidimensional phenomenon, since the evolution of multi-attribute inequalities is not always the same as that of income inequality. Nevertheless, she specifies that her conclusions are a function of the values of the parameters, which have a strong impact on final results. It will be interesting to see whether our conclusions agree with hers.

As for the unidimensional case, we consider three samples: the first comprises all individuals between 16 and 75 years of age; the second considers individuals between 16 and 25 years of age while the third considers individuals aged between 26 and 33. We also distinguish the cases of two attributes (wages and education) and three attributes (wages, education and health), to see whether information contributed by a third attribute changes our results.

When we consider the first sample (Table 6), results show that whatever the value of the parameter, whatever the number of attributes, and whatever the indicator used, wages inequalities impose their evolution on the multidimensional indices of inequality.

In the unidimensional results, recall that wage inequality had the greater amplitude of variation between the different years, far beyond those of education and health. Considering one or two additional attributes lowers the magnitude of the change in inequality. It could therefore appear that moving to a multidimensional framework results in a "compensation effect". Confining the analysis to wage inequality overestimates the level of inequality in the population.

If we consider the results for the sub sample of individuals aged between 16 and 25 (Table 7), some important differences emerge.

When we consider the two attributes case, we see that for the Atkinson indicator, and for the period between 1993 and 1997, the multidimensional indicators follow the decrease of educational inequality while wage inequality was rising. These results are for a given *r*. As *r* increases, the effect of wage inequalities dominates the results. Recall that *r* translates aversion to inequality. Since it sakes on the same value for each attribute, we cannot distinguish between aversion to educational, wage or health inequality. On the other hand, it is clear that as the value of the parameter of inequalities aversion rises, more weight is given to highest level of unidimensional inequality, namely wages. All these

[11] Those axioms are derivated from those of the unidimensional case. For a survey, see Cowell (1985) for the unidimensional indicators and Savaglio (2001) for the multidimensional case.

results are confirmed by those in three dimensions. For the GINI coefficient results, we note the same phenomena for the two and three attributes cases, with evolution between 1993 and 1997 depending on the value of *r*. Here, *r* describes the weights given to the various dimensions.

Table 6: Multidimensional inequalities for the full sample.

Indicators	1991	(%)	1993	(%)	1997	(%)	2000
Atkinson							
Two attributes							
s=1/2,r=1/2	0.1179	+26.46	0.1491	-41.44	0.0873	+16.72	0.1019
s=1/2,r=3/4	0.0785	+34.27	0.1054	-43.83	0.0592	+22.30	0.0724
s=3/4,r=1/2	0.1052	+26.52	0.1331	-41.84	0.0774	+16.92	0.0905
Three attributes							
s=1/2,r=1/2	0.0745	+25.77	0.0937	-40.55	0.0557	+17.41	0.0654
s=1/2,r=3/4	0.0462	+33.98	0.0619	-43.94	0.0347	+23.34	0.0428
s=3/4,r=1/2	0.0695	+26.04	0.0876	-41.32	0.0514	+17.31	0.0603
Gini							
Two attributes							
r=1/2	0.1509	+15.44	0.1742	-22.33	0.1353	+10.57	0.1496
r=3/4	0.1836	+16.94	0.2147	-20.35	0.1710	+11.93	0.1914
Three attributes							
r=1/2	0.1032	+14.44	0.1181	-21.34	0.0929	+10.87	0.1030
r=3/4	0.1259	+15.65	0.1456	-19.23	0.1176	+12.16	0.1319

Table 7: Multidimensional inequalities for individuals between 16 and 25 years of age.

	1991	(%)	1993	(%)	1997	(%)	2000
Atkinson							
Two attributes							
s=1/2,r=1/2	0.0819	-10.01	0.0737	-1.90	0.0723	+38.04	0.0998
s=1/2,r=3/4	0.0595	-14.29	0.0510	+4.90	0.0535	+41.68	0.0758
s=3/4,r=1/2	0.0748	-11.10	0.0665	-1.20	0.0657	+38.36	0.0909
Three attributes							
s=1/2,r=1/2	0.0535	-10.84	0.0477	-1.05	0.0472	+38.77	0.0655
s=1/2,r=3/4	0.0361	-16.06	0.0303	+6.93	0.0324	+41.97	0.0460
s=3/4,r=1/2	0.0502	-11.15	0.0446	-1.12	0.0441	+38.77	0.0612
Gini							
Two attributes							
r=1/2	0.1204	-1.25	0.1189	-1.51	0.1171	+20.07	0.1406
r=3/4	0.1602	-3.25	0.1550	+1.42	0.1572	+19.59	0.1880
r_1=1/4,r_2=3/4	0.3939	-0.66	0.3913	-0.41	0.3897	+2.23	0.3984
Three attributes							
r=1/2	0.0823	-2.19	0.0805	-0.12	0.0804	+19.53	0.0961
r=3/4	0.1094	-4.11	0.1049	+2.86	0.1079	+19.09	0.1285
r_1=1/4, r_2=3/4, r_3=3/4	0.0642	-3.43	0.0620	-0.23	0.0606	+15.18	0.0698

Note: r_1 is the weight given to wages, r_2 the weight given to education and r_3, the weight given to health.

Table 8: Multidimensional inequalities for individuals between 26 and 33 years of age.

Indicators	1991	(%)	1993	(%)	1997	(%)	2000
Atkinson							
Two attributes							
s=1/2,r=1/2	0.0764	-6.41	0.0715	-11.61	0.0632	+20.41	0.0761
s=1/2,r=3/4	0.0525	-3.81	0.0505	-8.32	0.0463	+16.63	0.0540
s=3/4,r=1/2	0.0691	-6.22	0.0648	-12.19	0.0570	+21.23	0.0691
Three attributes							
s=1/2,r=1/2	0.0495	-6.46	0.0463	-10.37	0.0415	+20.72	0.0501
s=1/2,r=3/4	0.0317	-5.05	0.0301	-6.64	0.0281	+17.79	0.0331
s=3/4,r=1/2	0.0462	-6.49	0.0432	-10.88	0.0385	+21.30	0.0467
Gini							
Two attributes							
r=1/2	0.1125	+4.89	0.1180	-6.61	0.1102	+8.89	0.1200
r=3/4	0.1454	+8.05	0.1571	-5.60	0.1483	+7.35	0.1592
Three attributes							
r=1/2	0.0781	+3.07	0.0805	-5.96	0.0757	+10.04	0.0833
r=3/4	0.1012	+5.92	0.1072	-5.04	0.1018	+8.64	0.1106

If we take the same weight for each argument, we see that when *r* rises, the most important inequalities in level (that is to say wage inequalities), impose again their evolution. When we give more weight to education inequalities (*r* differs between attributes, what is allowed by GINI's multidimensional coefficient), we can find again the superiority of the evolution of education inequalities.

Our results indicate that considering multidimensional inequality adds important information concerning inequality in overall well-being.

Results relative to the 26-33 years of age cohort (Table 8) confirm the compensation effect found earlier.

Here, the effect is strong enough to invert the trend for the GINI coefficient between 1991 and 1993. The increase of unidimensional inequality in education more than compensates for the decrease of wage and health inequalities. For the GINI coefficient in the unidimensional case, inequality in education rose more than wage and health inequalities decreased. The results do not change appreciably for different values of r.

5. CONCLUSION

Generally speaking, this paper shows that, in the Chinese case, considering income alone in describing inequality is inappropriate in that well-being goes well beyond income. Access to knowledge and to health are also fundamental determinants of welfare.

Even though aggregation of various dimensions could appear at first to result in a loss of information, having a single measure which sums up the level of multidimensional inequalities can give a global picture of the situation in a country.

China is a country that has experienced, with its transition to a market economy, an increase in disparities between individuals. We show in this paper that wage inequalities, after a decrease between 1993 and 1997, are now on the increase.

Concerning education and health, we showed that it is important to distinguish between individuals affected by the reforms from those who are not, since levels of education and health status depend on decisions taken earlier. We therefore considered inequalities in three different cohorts. The first was composed of the full sample, that is to say about individuals between 16 and 75 years of age. The second comprised individuals aged between 16 and 25, given that the reforms had an impact on children aged between 0 to 5 years in 1980 and thereafter. The third sub sample was composed of individuals aged between 26 and 33, since the nutrition status of adults is a function of their nutrition as children between 6 and 13 years of age and given that the reforms had consequences on this last population from 1980 and onwards.

With this distinction in mind, we found that, for education, after a period of rapid increase following the reforms, inequalities have tended to fall. For health, we found a rise in inequalities, irrespective of the cohort considered, between 1997 and 2000, translating both the decrease in government expenditures for health care (seen through the increase of inequalities in the 16-25 cohort) and difficulties in the access to food (seen through the increase of inequalities in the 26-33 cohort).

When we considered multidimensional inequality, we found that a compensation effect appears when we consider several dimensions, reducing the magnitude of the variations or even more leading to reversals of the evolution of unidimensional inequality in wages. Considering wage inequality alone overestimates the increase in inequality in the

population and may not accurately translate the real evolution of aggregate welfare. We also noted that our results depend on the value of the parameters which describe aversion to inequality and the weights given to the different attributes. It will be particularly important, in the future, to estimate these parameters so that they accurately reflect individual preferences in terms of their priorities (see Atella *et al.* (2004) for an example).

Whatever the dimensions and whatever the cohorts considered, inequalities have strongly risen during the years 1997-2000. The difference between the results found in the unidimensional and the multidimensional cases show the importance of considering attributes other than wages or income when we describe welfare inequalities in China.

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